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Original Article

GEO-ECOLOGICAL CHANGE OF BORDER AREAS BETWEEN KHASI HILLS AND SOUTHERN PLAINS OF ASSAM: A CASE STUDY WITH GEOMATICS APPROACH

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ABSTRACT

The Assam-Khasi hills border area with its ironic natural endowments and resource luxuriance craft a hot spot for GIS application in forest resource assessment. Increasing population and transforming land use pattern in the regions is molding an intricate inconsistent man-environment relationship with perpetual enigma between wildlife conservation and livelihood necessities of people. Change matrix is constructed by using Change Detection and Normalized Difference Vegetation Index (NDVI) for comparison of the temporal shift in land cover along with the wetlands as well as swamps, contiguous to piedmont areas of Khasi hills using the LANDSAT 7 and LISS III imageries. In this melting pot of nature, encroachment of forest and developmental activities adjacent to ecologically opulent wetlands cause man and wild animal conflict as well as jeopardy of environmental degradation. With the help of Remote Sensing and GIS, special emphasis on geo-ecological change like the impact of urbanization, depletion of wild habitat, man-animal conflict and a relationship between surface runoff and land cover changes have been done.

KEYWORDS: Khasi-Assam Border, Wildlife Conservation, Geo-Ecological Change, NDVI, GIS & Remote Sensing

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INTRODUCTION

The Assam-Khasi border area is an ecologically vibrant region with rich endowments of flora and fauna, which is an integral part of the Indo-Burman biodiversity hotspot. The concept of the border in this area is somewhat a complex blend of socio-cultural intermingling process, throughout the pages of historical policies. In these melting pots of natural benefactions, innumerable sites of opulent flora and fauna are present gloriously. Sal (Shorea Robusta), Makai (Shorea Assamica), Bonsum (Phoebegoal parents), different varieties of bamboos are some common vegetation species found in the region. In addition, considerable extension of the moist deciduous forest, combined with patches of evergreen forest found in the interior parts. This border area is also enriched with primordial migration corridors of Asian Elephants (Elephus maximus). Though Meghalaya has become a full-fledged state in 1972, and its boundary with Assam has been demarcated through North-Eastern Areas Reorganization Act, 1971, a dispute regarding the boundary is a frequently occurred phenomenon between the two states with growing population pressures and economic hassles of both the states. But the administrative line of area demarcation has not been efficacious in ruling out age-old socio-cultural, economic cross-border interdependency among inhabitants of these states.

The environmental interdependency of both the states, especially in the border region, is so grave that any kind of impairment to the environment, done in the Meghalaya side may produce an ecological imbalance in Assam's side and vice versa. The wanton and haphazard urbanization process in the side of Assam with the fast growth of population and transportation facility has initiated large-scale geo ecological changes in the area with heavy detrimental effects on the natural environment. On the side of Meghalaya, disorganized colossal deforestation and accumulative mining activities have threatened the sustainability of ecological diversity. Such geo ecological changes that have been taking place in this border region has commenced various problems of depletion of forest and wild habitat, man-animal conflict along with complications of the flash flood as well as heavyweight siltation connected to land cover changes in a multifarious but byzantine way.

GIS has great relevance in the assessment of geo-ecological change and retaining a spatial database regarding biodiversity characterization. A. R. R. Menon & N. Sasidharan (2005) and Prasanth Meiyappan et al. (2016) have contributed significantly in this domain. Goswami et al. (2016) carried out land use change detection study along the 25 villages of Jaintia Hills including evaluation of community forest management throughout the area. The increasing deforestation and unscientific land cutting process on the higher parts of Khasi hills have been adversely influencing the lower Piedmont areas of Assam. Burgeoning soil erosion and landslides in the craggy slopes of Khasi Hills often create the heavy siltation problem in rivers, rivulets, and drains of Guwahati city, creating chronically inundated zones by flooding and waterlogging (Barman & Goswami, 2009). The frequent controversy regarding the boundary between Assam and Meghalaya and rules of forest ownership in Meghalaya have considerable stimulus in the aggregating complexity of the situation.

RESEARCH OBJECTIVES

- To identify the changes that has been occurred in this border area in land use dynamics by the use of temporal satellite imagery data
- To see the vegetation cover changes, ensued in the area through initiation of different economic activities with NDVI application
- To find out the relationship between land use pattern changes and geo-ecological changes that have been taking place in the area, with special emphasis on valuation of impact of urbanisation, man-animal conflict and newly emerging threats to age-old environmental and socio-economic sustainability of the area.

STUDY AREA

The Border area between Khasi hills and southern plains of Assam and Deepor Beel has been taken as the study area, which is extracted with the help of 10 km and 2 km buffer respectively. During our study, the border area is considered less as a politically divided region or more as a magnificent distinct region with plentiful biodiversity. The border is much more psychologically generated division through political and administrative imposition, but culturally and geographically it is hard to fix.

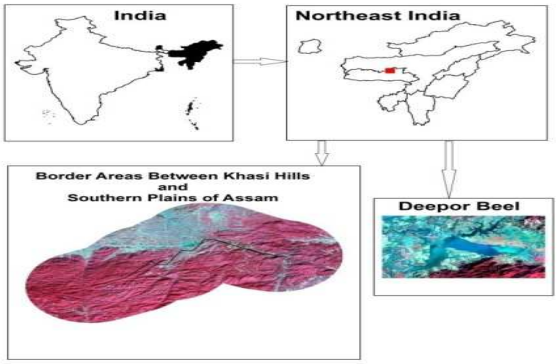

Figure 1: Location of Study Area

DATA USED AND METHODOLOGY

The Remote Sensing images like IRS RESOURCESAT 2 LISS III and LANDSAT ETM$^+$ are used in the study. Firstly the detailed study area has been demarcated through buffering with a 10km radius, whereas the area for Deepor Beel has been extracted with a 2 km buffer. With the help of satellite imageries, land use and land cover map have been prepared for the year 1977, 2004, 2007 and 2013. A Normalized Difference Vegetation Index (NDVI) is conducted to detect vegetation cover changes for temporal comparison of the detailed study area.

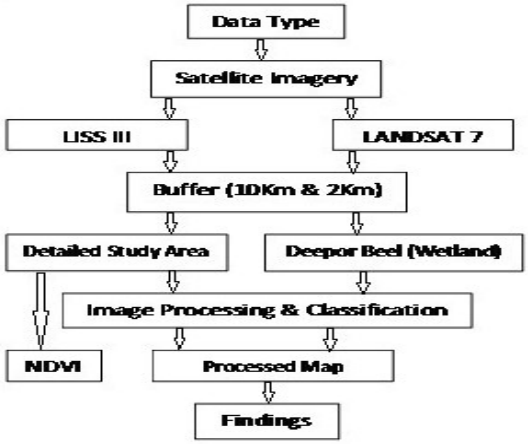

Figure 2: Methodology for Data Interpretation

LITERATURE REVIEW

Khasi hills as an integral part of Meghalaya, nature's abode of India, follow totally different rules and provisions regarding use and conservation of forest. The "State of the Environment Report, 2005, Meghalaya" resembles the fact that the environmental problems of the state can be divided mainly into three categories. The pulverized issues that have been commencing the greater environmental difficulties in the state are biodiversity loss, deforestation as well as shifting cultivation, which is categorized as the green issues. In the category of brown issues, more intricate anthropogenic issues with greater detrimental effects like coal mining and urbanization are included. Kiranmoy Sarma (2005) conducted a study on the impact of coal mining on the vegetation of Jaintia Hills of Meghalaya using satellite imagery as a primary tool of analysis. The tree species showed a drastic reduction in their composition and density in all the zones prepared according to different impact assessment of coal mining, throughout the mining areas than that of the un-mined areas. The result of change detection revealed a decrease of forest cover in the Jaintia hills from 25% of total area in 1975 to 16% of it in 2001,

as an unswerving impact of mining expansion (Sarma 2005). Kasturi Chakraborty & S. Sudhakar (2005) have analyzed the expansion and impact of cement manufacturing units and mining areas in Lumshong area of Jaintia Hills. In the study, remote sensing and GIS have been used for change detection on the ground which is further compared with the location of cement manufacturing units. The grander environmental problems with the deceitful nexus of innumerable interrelated environmental degradation processes like different kinds of pollution are included in the blue category (State of the Environment Report, 2005). Deepor Beel, one of the famous wetland of Assam- Meghalaya border area, is the supreme example of a Ramsar site where water pollution has generated a threat towards its biodiversity. Encroachment of the beer for different settlement and industrial purposes, garbage dumping within the edge of the beer along with inflow of Guwahati city sewage without provision of outflow have tremendously affect the ecological balance of the site with very high level of eutrophication, (Report on visit to Deepor Beel, The Ministry of Environment & Forest, 2008). Due to the construction of railway tracks within the boundary, the geo-ecological stability of this site has totally got distressed. As this site is adjoined to the migration corridors of Asian elephants in between Assam and Meghalaya such sudden environmental change has certainly hampered their free movement in the area, with presence of some deadly railway tracks. A. Choudhury (2004) forwarded that human-elephant conflict has become a conjoint traumatic event of Northeast India, as more than half of the elephant habitat has been lost since 1950. Deforestation for shifting cultivation, encroachment of human in elephant habitat and developmental activities along the elephant migration routes are foremost causes behind human-elephant conflict in the North Eastern India, where only 25% of the habitat of elephant comes under protected areas (Choudhury, 2004).

GIS and Remote Sensing plays a great role in providing an analytical overview of environmental transformation throughout the globe. CY Ju et al. (2000) involved in study, of coastal area sustainability assessment by the use GIS where geo-environmental factors of Laoshan district of China are evaluated in the light of multifaceted transforming dynamics of development. P. K. Sarma, Arup Kr Das & B. K. Talukdar (2013), analyzed the transforming forest cover and wildlife habitat of Kamrup metropolitan district with geospatial approach. They identified 19 notified forest areas in the district where it resembles that areas of human settlement, agriculture, and industries are expanding at the expense of wildlife habitat. The presence of shifting cultivation in these areas, specifically in Rani RF (6.27%), Garbhanga RF (8.12%), Khanapara Reserve Forest (4.36%) and Agricola West Reserve Forest (11.96%), situated in the border of Khasi Hills and Assam, shows the transmuting landscape of geo-ecology in our study area. Jahan Saherah, S. Kalita & B. B. Kumar (2015), uses Geoinformatics in assessing land use changes in Sonai-Rupai Wildlife Sanctuary. They get a tragic result after their analysis that within the sanctuary, the amount of degraded land was 7.56 square km in 1988 which increased up to 78.74 square km in 2005. R. K Jaisawal, Rajesh Saxena & S. Mukherjee (1999) analyzed the land cover change of mid-western part of Gohparu area of Madhya Pradesh through remote sensing technology with a detailed classification of forest cover.

RESULT AND DISCUSSIONS

Change Detection

An area under major land use categories is calculated for the purpose of change analysis for the years 2004 and 2013 (Table 1). Land use has been categorized into four classes viz. settlements, vegetation cover, fallow and agricultural land as well as water bodies during the study.

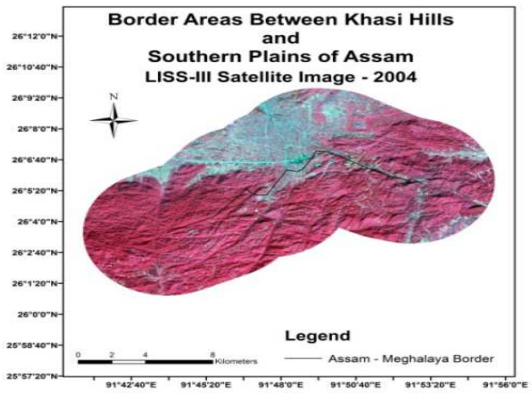

Figure 3: Satellite Imagery of the year 2004 (10 Km Buffer)

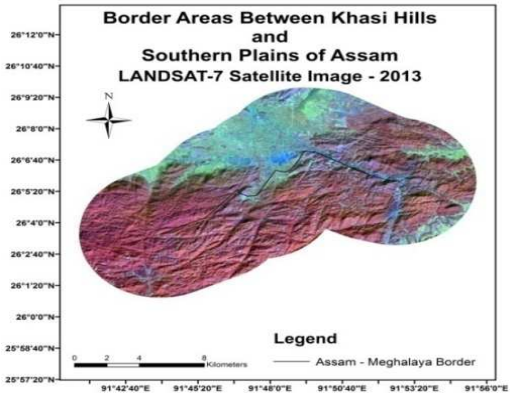

Figure 4: Satellite Imagery of the year 2013 (10 Km Buffer)

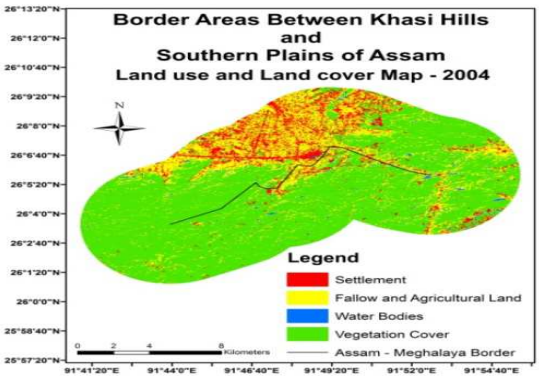

Figure 5: LU/LC Map of the Year 2004

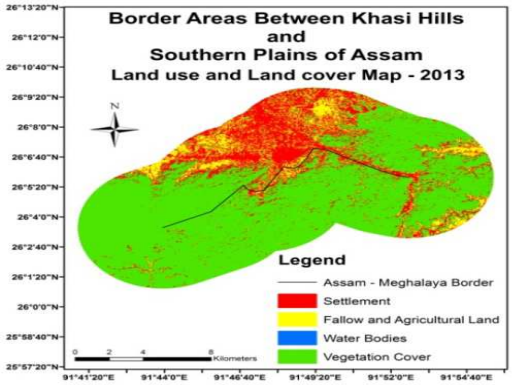

Figure 6: LU/LC Map of the Year 2013

Table 1: Area in Percentage (%) Under Different Land Use Categories in Different Periods

Land use Category	Area In Sq Km	
	2004	2013
Settlement	22.47	50.20
Fallow and Agricultural Land	52.63	23.15
Water Bodies	2.61	0.02
Vegetation Cover	174.97	179.31
TOTAL	**252.68**	**252.68**

Table 2: Category-Wise Changes of Land Use Area (in Sq Km)

Land use Category	Area In Percentage (%)	
	2004	2013
Settlement	9	20
Fallow and Agricultural Land	21	10
Water Bodies	1	0
Vegetation Cover	69	70
TOTAL	**100%**	**100%**

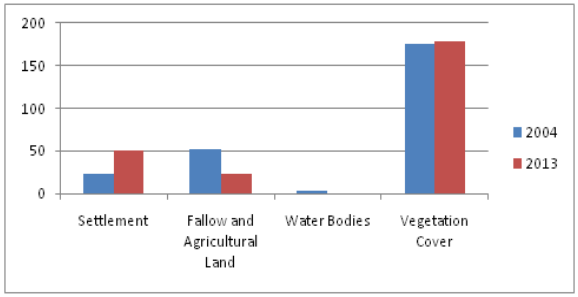

Figure 7: Graph Showing the Differences in Area of the Year 2004 & 2013

Change in Vegetation Cover

Vegetation cover has shown an increase of 1% to total area under study during the study period. But the category wise variation of vegetation cover significantly changed as reflected in the maps under study.

Change in Settlement Areas

Rapid population growth has produced a speedy wanton increase in settlement area of the study area. The area under settlement has increased from 22.47 km2 in 2004 to 50.20 km2 in 2013. Such hasty expansion of human habitat has initiated enormous geo-ecological changes during the study period.

Change in Fallow and Agricultural Land

A major change has recorded in the fallow and agricultural land as a direct impact of an increase in human settlement in the study area. The collective effect of periphery expansion of Guwahati city and escalating land value has initiated a fast transformation of fallow and agricultural lands into settlement areas.

Change in Water Body

A small but significant decrease is noticed in the area in case of the water body. The area under water body has been decreased from 2.61 km2 in 2004 to 0.02 km2 in 2013. The main reason behind the change is the enormous land - filling activities in the area for the purpose of settlement and infrastructure development. The seasonal variation between the images also affects the variation rate.

Vegetation Index

With the help of NDVI (Normalized Difference Vegetation Index) for imageries of the year 2004 and 2013, the variation of the vegetation cover has been studied in detail in the study area. It has been noticed that vegetation cover within the area has remained more or less same during the study period.

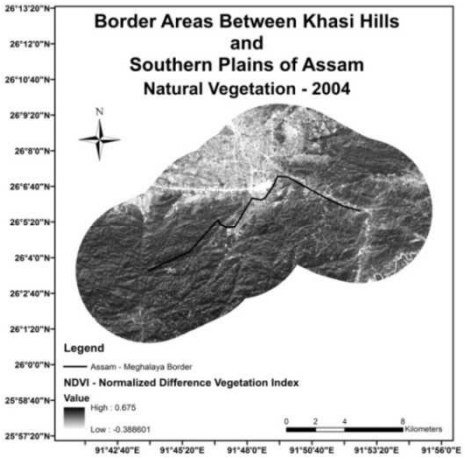

Figure 8: NDVI Map of Year 2004

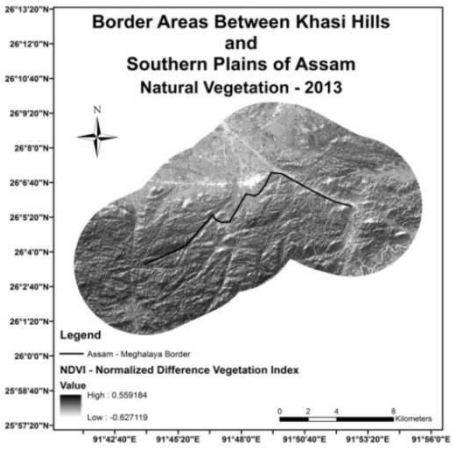

Figure 9: NDVI Map of Year 2013

Geo-Ecological Change Detection of Deepor Beel

To comprehend the geo-ecological change of the border area in an inclusive angle, the land use and land cover change detection of Deepor Beel has taken into consideration, as this wetland is the most biologically rich part of the Piedmont area of Khasi Hills.

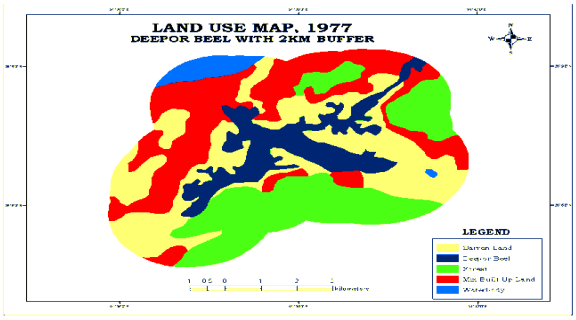

Figure 10: LU/LC Map of Deepor Beel, Year 1977

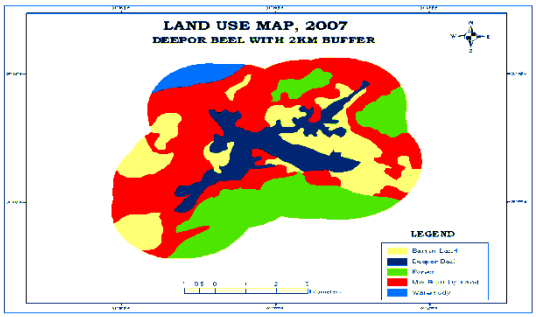

Figure 11: LU/LC Map of Deepor Beel, Year 2007

Table 3: Area in Sq Km Under Different Land Use Categories

Land use Category	Area In Sq Km	
	1977	2007
Water Body	1.98	1.9
Forest	16.8	14.8
Deepor Beel Proper	9.3	8.78
Barren/Crop Land	19.2	12.8
Mixed Built up Area	17.3	26.4
Total	**64.68**	**64.68**

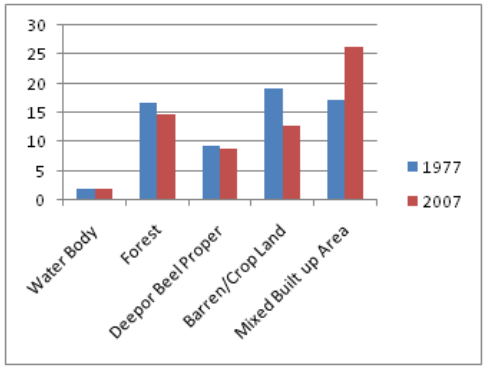

Figure 12: Graph Showing the Differences in Area

Though the water body of the beel has recorded slight decrease in the beer, the proper area under the beer has resembled a significant decrease from 9.3 km^2 in 1977 to 8.78 km^2 in 2007. The main factor behind this devious transformation is the increase in the mixed built -up area around the beer. The expanding urbanization process of Guwahati city with an amassed increase in the dwelling and industrial units especially brick kiln factories has significantly influenced the environment of the area. The cropland under the buffer zone, we have taken, has decreased because these lands have been continuously transforming to build areas with increasing land demand throughout the area (Sharma, 2017).

CONCLUSIONS

This study has proved that the border area between the Khasi hills and Southern plains of Assam has undergone through enormous geo-ecological transformation. Though the area has not faced a decrease in vegetation cover, in the Assam's side, overall environmental balance of the area has been threatened through haphazard built up development than that of the Meghalaya counterpart. The growth of infrastructure along with tremendous population pressure and unplanned urbanization has created difficulty for the floral as well as the faunal diversity of the area. The existing comprehensive forest laws have to strictly enforce. Those laws have to apply on the ground level through the creation of awareness among the people of both the states. A participatory conservation method has to be forwarded, upholding the age-old traditional customs of the community forest. The dispute between the states regarding the boundary has to be resolved as it is creating bottlenecks in the conservation process. To protect the area, especially the Deepor Beel wetland from this distress a sustainable protection, restoration and management plan has to be constructed.

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